ELECTROMOTIVE SWASH PLATE TYPE COMPRESSOR

TECHNICAL FIELD

The present invention relates to a compressor with an electromotive swash plate, and more particularly, to a multi-stage compressor with an electromotive swash plate.

BACKGROUND ART

Generally, an air conditioner for a vehicle compresses a refrigerant in a compressor, condenses the compressed refrigerant in a condenser, and transmits the condensed refrigerant to an expansion valve. Then, the expansion valve converts the condensed refrigerant into wet vapor with low temperature and low pressure and transmits the wet vapor to an evaporator. The wet vapor transmitted to the evaporator is heat-exchanged with external air to absorb heat of the external air and is then returned to the compressor for recirculation.

The compressor used for compressing the refrigerant functions to (a) intake a heat-exchange medium evaporated in the evaporator, (b) compress the heat-exchange medium, and (c) pump out the heat-exchange medium for the continuous circulation of the heat-exchange medium. Such a compressor is classified, according to a driving manner, into a swash plate type, a scroll type, a rotary type, and a wobble plate type.

The swash plate type compressor comprises a cylinder block having a plurality of bores in which respective pistons reciprocate. The cylinder block is fixed by front and rear housings. A driving shaft is installed in a central portion of the cylinder block. A swash plate is inserted in the cylinder block and coupled to the driving shaft. As the swash plate rotates, the pistons successively reciprocate in a longitudinal direction of the cylinder block. The swash plate type compressor is classified into a single-head type, where the compression is realized in a sided portion, and a double-head type, where the compression is realized in opposite sides. The latter comprises low and high-pressure chambers formed in the rear housing. The low-pressure chamber is provided to allow the refrigerant to be introduced into the cylinder via a valve assembly and the high-pressure chamber is provided to compress the refrigerant using the

pistons. The pistons are formed of a dual-head piston to alternatively compress the refrigerant to the high-pressure chambers of the front and rear housings. The refrigerant compressed to the high pressure chamber of the front housing is discharged to the rear housing through a communication passage formed between the cylinder and the bore, and is then further discharged to a discharge chamber of a manifold installed on an external side of the compressor.

The valve assembly is formed between inner surfaces of the front and rear housings and external opposite ends of the cylinder to allow the refrigerant in the fluid passage to be introduced into the cylinder and to control the flow of the refrigerant when the introduced refrigerant is compressed by the pistons. That is, in accordance with the operation of the valve assembly, the refrigerant is introduced into the cylinder and compressed by the piston. The compressed refrigerant is discharged out of the compressor by the valve assembly.

As a power source for rotating the driving shaft of the compressor, an engine or a motor may be used. The motor is generally used for a scroll type compressor and a single-head swash plate type compressor. The compressor using the motor comprises a motor part and a compressing part for compressing the refrigerant.

Japanese Laid-open patent publication No. 2001-193639 discloses a single-head swash plate type compressor in which gas that is primarily compressed at a side is recompressed by a piston corresponding to a next rotation turn.

In this swash type compressor, while the discharge direction of the refrigerant is uniform, but discharge pressure is not uniform, thereby deteriorating the operational reliability due to the variation of the discharge pressure pulsation and torque.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a sectional view of a compressor with an electromotive swash plate according to an embodiment of the present invention;

FIG. 2 is a perspective view of a cylinder block depicted in FIG. 1;

FIG. 3 is a sectional view taken along line A-A of FIG. 1;

FIG. 4 is a sectional view taken along line B-B of FIG. 1;

FIG. 5 is a sectional view of a compressor with an electromotive swash plate according to another embodiment of the present invention;

FIG. 6 is a sectional view taken along line C-C of FIG. 5; and

FIG. 7 is a sectional view taken along line D-D of FIG. 5.

DETAILED DESCRIPTION OF THE INVENTION

Technical Goal of the Invention

The present invention provides a compressor with an electromotive swash plate, which can provide uniform discharge pressure.

The preset invention also provides a compressor with an electromotive swash plate, which can improve compression efficiency.

The present invention also provides a compressor with an electromotive swash plate, which can improve lubrication for the operation of a swash plate in a swash plate chamber.

The present invention also provides a compressor with an electromotive swash plate, which has improved durability.

The present invention also provides a compressor with an electromotive swash plate, which can stabilize a discharge pressure pulsation and a torque variation.

Disclosure of the Invention

In an aspect of the present invention, there is provided a compressor with an electromotive swash plate, comprising: a front housing having a front discharge chamber for discharging a firstly compressed refrigerant; a rear housing having a rear suction chamber communicating with the front discharge chamber to receive the firstly compressed refrigerant and a rear discharge chamber discharges a secondly compressed refrigerant, the rear suction chamber and the rear discharge chamber being divided by a partition; a cylinder block disposed between the front and rear housings, the cylinder block being provided with a swash plate chamber receiving the swash plate, a plurality of bores in which respective pistons are slidably installed, a

discharge gas passage for assigning a refrigerant flow between the front and rear housings; a driving shaft mounted in the cylinder block, the driving shaft being rotated by a motor received in a motor chamber formed adjacent to one of the front and rear housings; and a plurality of dual-head pistons reciprocating in the bore due to the inclination of the swash plate.

The compressor may further comprise a transferring unit for transferring the refrigerant introduced into the swash plate chamber to the motor chamber and a recovering unit for recovering the refrigerant from the motor chamber to the cylinder bores.

The transferring unit may be a transferring passage formed through one of the front and rear housings to allow the swash plate chamber to communicate with the motor chamber.

The recovering unit may be a suction passage formed through one of the front and rear housings to allow the motor chamber to communicate with the cylinder bores.

The front housing may further comprise a front suction chamber communicating with the swash plate chamber through a low pressure communication passage formed on the cylinder block to receiving the refrigerant from the swash plate chamber.

The rear suction chamber may be formed around the rear discharge chamber of the rear housing.

The rear discharge chamber may be provided with a discharge passage defined by a discharge pipe for reducing a discharge pressure pulsation.

The discharge gas passage may be formed to allow the front discharge chamber to communicate with the rear suction chamber.

Effect of the Invention

The above-described compressor according to the present invention has the following advantages.

First, as the refrigerant is introduced into the swash plate chamber, the lubrication for the operation of the swash plate can be maximized.

Second, the refrigerant directed to the motor chamber can prevents the motor efficiency from being deteriorated by demagnetisation due to the increase of the temperature.

Third, as the compression is realized at opposite side to discharge high pressure and high temperature refrigerant, the motor efficiency can be prevented from being deteriorated by demagnetisation due to the increase of the temperature of the refrigerant.

Fourth, since double-head pistons are used, the inclined angle of the swash plate can be reduced, thereby improving durability of the compressor.

Fifth, since the discharge direction of the refrigerant is uniform and the refrigerant is stored in an identical chamber, the discharge pressure pulsation and the torque variation can be stabilized.

Sixth, since the compression is realized twice, the compression efficiency can be improved.

Seventh, since carbon dioxide is used as the refrigerant, the displacement volume can be reduced.

BEST MODE FOR CARRYING OUT THE INVENTION

FIG. 1 is a sectional view of a compressor having an electromotive swash plate according to an embodiment of the present invention. FIG. 2 is a perspective view of a cylinder block of the compressor.

Referring to FIGS. 1 and 2, the compressor 10 comprises a driving shaft 13 driven by a power source 12; a swash plate 14 installed on the driving shaft 13 at a predetermined inclined angle to rotate together with the driving shaft 13; a plurality of double-head pistons 15 reciprocating by the rotation of the swash plate 14; a front housing 16 having a front suction chamber 16a for receiving refrigerant and a front discharge chamber 16b for discharging firstly compressed refrigerant, the front housing being divided by a partition; a rear housing 17 including a rear suction chamber 17a and a rear discharge chamber 17b divided by a partition, the rear suction chamber 17a communicating with the front discharge chamber 16b to receive the firstly compressed refrigerant and a rear discharge chamber 17b for discharging secondly compressed

refrigerant; a cylinder block 18 disposed between the front and rear housings 16 and 17 to rotatably support the driving shaft 13, the cylinder block 18 being provided with a plurality of bores 18a in which the respective pistons 15 are slidably installed, a suction passage 18b through which the refrigerant is introduced from an external side, a swash plate chamber 18c receiving the swash plate 14 and communicating the suction passage 18b, a plurality of communication passages (18d in FIG. 3) communicating with both the front suction chamber 16a and the swash plate chamber 18c; and a valve assembly 19 disposed between the front housing 16, the rear housing 17 and the cylinder block 18. The power source 12 may be a motor 12 installed in a motor chamber 11. Alternatively, a driving power of the engine may be directly used as the power source 12.

FIG. 3 shows a sectional view taken along line A-A of FIG. 1, in which dotted lines indicate locations of the communication passages 18d of the cylinder block 18, a discharge gas passage 18e, the piston 15, suction and discharge valves 19a and 19b of the valve assembly 19.

Referring to FIG. 3, the front housing 16 is provided in the center with a driving shaft mounting hole 16c. The front discharge chamber 16b for discharging the firstly compressed refrigerant is provided around the driving shaft mounting hole 16c. The front suction chamber 16a is provided around the front discharge chamber 16b. The refrigerant is introduced into the front suction chamber 16a through the suction passage 18b of the cylinder block 18 according to the operation of the valve assembly 19 and is then firstly compressed by the pistons 15. The firstly compressed refrigerant is directed to the front discharge chamber 16b of the front housing 16, and is then further directed to the rear suction chamber 17a through the discharge gas passages 18e.

FIG. 4 shows a sectional view taken along line B-B of FIG. 1, in which dotted lines indicate locations of the discharge gas passages 18e, the pistons 15, and the suction and discharge valves 19a and 19b of the valve assembly 19.

Referring to FIG. 4, the rear housing 17 is provided with a driving mounting hole 17c. The refrigerant is introduced from the front discharge chamber 16b of the front housing 16 to the rear suction chamber 17a of the rear housing 17. The refrigerant is secondly compressed in the rear housing 17 and is then discharged to the external side

through the discharge passage 17d formed of a boss to reduce the discharge pressure pulsation.

As the refrigerant, carbon dioxide that can enhance the reduction of displacement volume as compared with other refrigerants may be used.

The space formed by the front housing 16, a motor chamber 11, and the rear housing 17 is partitioned. The front discharge chamber 16b divided by an internal partition of the front housing 16 and the rear suction chamber 17a divided by an internal partition of the rear housing 17 are communicated with each other by the discharge gas passages 18e.

The front housing 16, the rear housing 17, the motor housing 11a defining the motor chamber 11, and the cylinder block 18 are coupled to each other by bolts (not shown), defining a cylindrical shape of the compressor.

The driving shaft 13 extends through a space defined by the motor chamber 11 and the front and rear housings 16 and 1 7. Both ends of the driving shaft 13 are respectively supported on the motor housing 11a and the cylinder block 18 by radial bearings 13a and 13b. The driving shaft 13 penetrates the mounting hole 16c of the front housing 16 and a seal member (not shown) is tightly disposed between the driving shaft 13 and an inner circumference of the mounting hole 16c.

The power source 12 is a motor received in the motor chamber 11, having a stator 12a and a rotor 12b rotating the driving shaft 13. The swash plate 14 is fixed around the driving shaft 13 to rotate together with the driving shaft 13. Opposite ends of the swash plate 14 are supported in the cylinder block 18 by thrust bearings 14a.

The cylinder block 18 includes front and rear cylinder blocks 18' and 18"that are assembled with each other. The suction passage 18b introducing the refrigerant to the swash plate chamber 18c is formed on an upper portion of the rear cylinder block 18". The suction passage 18b may be formed on the front cylinder block 18'as far as the suction passage 18b is connected to the swash plate chamber 18c. As described above, the cylinder block 18 is provided with cylinder bores 18a in which the respective pistons 15 can reciprocate and the mounting hole 18f for mounting the driving shaft 13.

The valve assembly 19 is disposed between the front housing 16, the rear housing 17 and the cylinder block 18 to control the flow of the refrigerant between the

suction chambers 16a and 17a, the discharge chambers 16b and 17b, and the bore 18a.

The operation of the above-described compressor with the electromotive swash plate will be described hereinafter.

The refrigerant is introduced from the exterior to the front chamber 16a of the front housing 16 via the suction passage 18b and communication passage 18d of the cylinder block 18 and the swash plate chamber 18c, and the refrigerant functions as lubricant for the operation of the swash plate 14. The refrigerant introduced into the front suction chamber 16a is firstly compressed in the front housing 16 and stays in the front discharge chamber 16b of the front housing 16. The firstly compressed refrigerant is introduced into the rear suction chamber 17a of the rear housing 17 via the discharge gas passage 18e and is then secondly compressed. The secondly compressed refrigerant is discharged to the exterior via the rear discharge chamber 17b of the rear housing 17.

EMBODIMENT

FIG. 5 shows a compressor with an electromotive swash plate according to another embodiment of the present invention.

Referring to FIG. 5, a compressor 40 of this embodiment comprises a driving shaft 43 driven by a motor 42 disposed in a motor chamber 41; a swash plate 44 installed on the driving shaft 43 at a predetermined inclined angle to rotate together with the driving shaft 43; a plurality of double-head pistons 45 reciprocating by the rotation of the swash plate 44; a front housing 46 having a suction passage 46a for receiving refrigerant from the motor chamber 41 and a front discharge chamber 46b for discharging firstly compressed refrigerant; a rear housing 47 having a rear suction chamber 47a communicating with the front discharge chamber 46b to receive the firstly compressed refrigerant and a rear discharge chamber 47b for discharging secondly compressed refrigerant; a cylinder block 48 disposed between the front and rear housings 46 and 47 to rotatably support the driving shaft 43, the cylinder block 48 being provided with a plurality of bores 48a in which the respective pistons 45 are slidably installed, a suction passage 48b through which the refrigerant is introduced from an

external side, and a swash plate chamber 48c receiving the swash plate 44 and communicating the suction passage 48b; a valve assembly 49 disposed between the front housing 46, the rear housing 47 and the cylinder block 48; and a refrigerant transfer passage 50 for transferring the refrigerant from the swash plate chamber 48c to the motor chamber 41.

The space formed by the front housing 46, the motor chamber 41 adjacent to the front housing 46, and the rear housing 17 is partitioned. The front housing 46 further include a suction passage 46a receiving the refrigerant. The front discharge chamber 46b and the rear suction chamber 47a are communicated with each other by discharge gas passages 48e (see FIG. 6).

The front housing 46, the rear housing 47, the motor housing 41a defining the motor chamber 41, and the cylinder block 48 are coupled to each other by bolts (not shown), defining a cylindrical body of the compressor.

The driving shaft 43 is formed extending through a space defined by the motor chamber 41 and the front and rear housings 46 and 47. Both ends of the driving shaft 43 are respectively supported on the motor housing 41a and the cylinder block 48 by radial bearings 43a and 43b. The driving shaft 43 penetrates a mounting hole 46c of the front housing 46 and a seal member (not shown) is tightly disposed between the driving shaft 43 and an inner circumference of the mounting hole 46c.

The motor 42 is received in the motor chamber 41, having a stator 42a and a rotor 42b rotating the driving shaft 43. The swash plate 44 is fixed around the driving shaft 43 to rotate together with the driving shaft 43. Opposite ends of the swash plate 44 are supported in the cylinder block 48 by thrust bearings 44a.

The cylinder block 48 includes front and rear cylinder blocks 48' and 48"that are assembled with each other. The suction passage 48b introducing the refrigerant to the swash plate chamber 48c is formed on an upper portion of the rear cylinder block 48". The suction passage 48b may be formed on the front cylinder block 48'as far as it is connected to the swash plate chamber 48c. As described above, the cylinder block 48 is provided with the cylinder bores 48a in which the respective pistons 45 can reciprocate and the mounting hole 48f for mounting the driving shaft 43.

The valve assembly 49 is disposed between the front housing 46, the rear housing 47 and the cylinder block 48 to control the flow of the refrigerant between the suction passage 46a, the front discharge chamber 46b, the rear suction chamber 47a, the rear discharge chamber 47b, and the bores 48a.

FIG. 6 shows a sectional view taken along line C-C of FIG. 5, in which dotted lines indicate locations of a discharge gas passage 48e, the pistons 45, a discharge valve 49b of the valve assembly 49.

Referring to FIG. 6, the front housing 46 is provided in the center with a driving shaft mounting hole 46c. The front discharge chamber 46b discharging the firstly compressed refrigerant is provided around the driving shaft mounting hole 46c. The front suction passage 46a is provided around the front discharge chamber 46b. The refrigerant introduced into the motor chamber 41 through the refrigerant transferring passage 50 is supplied to the bores 48a of the cylinder block 48 by the valve assembly 49 and is then firstly compressed by the piston 45. The firstly compressed refrigerant is directed to the front discharge chamber 46b of the front housing 16, and is then further directed to the rear suction chamber 47a through the discharge gas passages 48e. Although not illustrated, the front housing 46 may further include a front suction chamber.

FIG. 7 shows a sectional view taken along line D-D of FIG. 5, illustrating the rear housing depicted in FIG. 5.

Referring to FIG. 7, the rear housing 47 is provided with a driving mounting hole 47c. The refrigerant introduced from the front discharge passage 46b of the front housing 46 stays in the rear suction chamber 47a of the rear housing 47. The refrigerant is secondly compressed in the rear housing 47 and then stays in the rear discharge chamber 47b of the rear housing 47. The secondly compressed, high-temperature, high-pressure refrigerant is discharged to the exterior through the discharge passage 47d formed of a boss reducing the discharge pulsation.

As the refrigerant for the above-described compressor with the electromotive swash plate, carbon dioxide that can enhance the reduction of displacement volume as compared with other refrigerants may be used.

The operation of the above-described compressor with the electromotive swash plate will be described hereinafter.

The refrigerant is introduced from the external side to the swash plate chamber 48c through the suction passage 48b of the cylinder block 48, and the refrigerant functions as lubricant for the operation of the swash plate 44 of the swash plate chamber 48c. The refrigerant introduced into the swash plate 48c is directed to the motor chamber 41 through the transferring passage 50 to cool the motor 42, thereby preventing the motor efficiency from being deteriorated by demagnetisation due to the increase of the temperature. The refrigerant is then directed to the bores 48a of the cylinder block 48 through the suction passage 46a to be firstly compressed in the front housing 46 and stays in the front discharge chamber 46b of the front housing 46. The first compressed refrigerant is introduced into the rear suction chamber 47a of the rear housing 47 via the discharge gas passage 48e. The refrigerant directed to the rear suction chamber 47a is secondly compressed and is then discharged to the exterior through the rear discharge chamber 47b of the rear housing 47.

The front and rear sides of the compressor may be exchanged. In addition, as the power source, an engine may be used instead of the motor.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.